comparatively exposed situations more compact leaves may be more suitable. It was pointed out that finely cut leaves are common among low herbs, and that some families which among the low and herbaceous species have such leaves, in shrubby or ligneous ones have leaves more or less like those of the laurel or beech.

Much light is thrown on the subject by a study of the leaves of seedlings. Thus the furze has at first trifoliate leaves, which gradually pass into spines. This shows that the furze is descended from ancestors which had trifoliate leaves, as so many of its congeners have now. Similarly, in some species which when mature have palmate leaves, those of the seedling are heart-shaped. He thought that perhaps in all cases the palmate form was derived from the heart-shaped. He then pointed out that if there were some definite form told off for each species then a similar rule ought to hold good for each genus. The species of a genus might well differ more from one another than the varieties of any particular species ; the generic type might be, so to say, less closely limited ; but still there ought to be some type characteristic of the genus.

He took, then, one genus, that of Senecio (the groundsel). Now in addition to Senecios more or less resembling the common groundsel, there were species with leaves like the daisy, bushy species with leaves like rosemary and the box, small trees with leaves like the laurel and the poplar, climbing species like the convolvulus and bryony. In fact the list is a very long one, and shows that there is no definite type of leaf in the genus, but that the form in the various species depends on the condition of the species. From these and other considerations he concluded that the forms of leaves did not depend on any inherent tendency, but to the structure and organisation, the habits and requirements of the plant. Of course it might be that the present form had reference to former and not to present conditions. Nor did it follow that the adaptation need be perfect. The tendency existed, just as water tends to find its level. This rendered the problem all the more complex and difficult.

The lecture was illustrated by numerous diagrams and specimens, and Sir John concluded by saying the subject presented a wide and interesting field of study, for if he were correct in his contention every one of the almost infinite forms of leaves must have some cause and explanation.

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xvi. fasc. 8.—On the oxidation of acetones, by E. Wagner (first paper dealing with their behaviour towards chromic acid).—On the specific volumes of chlorine, iodine, and bromine in organic compounds, by M. Schalfejeff (second paper). For chlorine they gradually rise with the increase of the number of equivalents entering into combination, gradually reaching 21, 24, and 27 ; for bromine they are 24, 27, and 30 ; and for iodine, 26 to 27.—Addition of methylamine to methylglycidic acid, by M. Zelinsky.— On Astrakhanite, by W. Markovnikoff.—On the influence of the linear compression of iron, steel, and nickel rods on their magnetism, by P. Bakmetieff. From a varied series of experiments the author arrives at a series of conclusions, showing that compression of iron rods exercises a very notable influence on their magnetisation, and that the phenomena depend upon the rods having been, or not, formerly submitted to repeated compression ; all kinds of iron and steel display the influence of compression—soft iron and steel at a higher degree than hard iron and steel. The theory of rotating molecular magnets would explain all observed phenomena.—On an amperometre based on the electrothermic phenomenon of Pelletier, by N. Hesehus.— On the regular forms taken by powders, by Th. Petrushevsky (second paper dealing with the shapes taken by heaps of powders on surfaces limited by curves, or polygones with entering angles).—Also on the dilatation of liquids ; an answer to Prof. Arenarius, by D. Mendeleeff.—An answer to M. Rogovsky, by B. Stankewitsch.—An answer to M. Sokoloff, by M. Bardsky, being a further mathematical inquiry into the forces of molecular attraction.—An answer to M. Petroff, by M. Kraevitsch.—We notice an innovation in this fasciculum of the *Journal*. It contains detailed minutes of the proceedings of the Physical and Chemical Section of the Moscow Society of Lovers of Natural Science.

Sitzungsberichte der Physicalisch-medicinishen Societät zu Erlangen, No. 16, October, 1883, to October, 1884.—Remarks on the phenomenon of phosphorescence in connection with the description of an instrument designed for studying the effect of the various spectral rays, and especially the ultra-red on phosphorising substances, by E. Lommel.—On the fluorescence of calcspar, by E. Lommel.—On the reduction of algebraic differential expressions to normal forms, by M. Noether.—Contributions to the knowledge of the Chytridiaceæ and other fungoid organisms, with thirty-seven illustrations, by D. C. Fisch. —On the malaria and intermittent fevers of the Erlangen district, by Prof. F. Penzoldt.—On the presence of microscopic organisms in the tissues of animals in the normal state, by Dr. Hauser.— Test of the sensitiveness of the visual organ to direct and oblique luminous rays, by Dr. Louis Wolffberg.—On algebraic differential expressions, and on Jacobi's reverse problem, by M. Noether.—On the systematic position of the yeast fungus, by M. Reess.—On two new species of Chytridiaceæ, by C. Fisch.—On the nerves of temperature and touch in the animal system, by J. Rosenthal.—On a means of determining the quantity of carbonic acid present in the atmosphere of rooms, by J. Rosenthal.—On the phenomenon of Uræmia, by Dr. R. Fleischer.—Toxicologic researches from the physiological standpoint, by J. Rosenthal.— On vertigo caused by intestinal affections, by W. Leube.—Experiments on the hatching of bird's eggs whose shells had suffered lesion, by Prof. L. Gerlach.—On Oidema, by Dr. R. Fleischer. —On the surgical operation of opening the mastoid process, by Dr. W. Kiesselbach.—On the life-history and pathological properties of a species of bacteria causing putrefaction, by Dr. G. Hauser.—On the histiology of primary carcinom in the osseous system, by Dr. von Düring.—On a case of lingual tuberculosis, by Dr. Ernst Graser.—On the after-treatment of external urethrotomy, by H. Knoch.

Rivista Scientifico-Industriale, December 31, 1884.—On the electric conductivity of the alcoholic solutions of some chlorides, by Dr. Joseph Vicentini.—Memoir on the variations in the electric resistance of solid and pure metal wires according to the temperature (continued), by Prof. Angelo Euro.

SOCIETIES AND ACADEMIES
LONDON

Royal Society, February 12.—" On Underground Temperatures, with Observations on the Conductivity of Rocks, on the Thermal Effects of Saturation and Imbibition, and on a Special Source of Heat in Mountain Ranges." By Joseph Prestwich, M.A., F.R.S., Professor of Geology in the University of Oxford.

The author remarks on the difference of opinion between physicists and geologists respecting the probable thickness of the outer crust of the earth—the former on the strength of its great rigidity and the absence of tides, contending for a maximum thickness and comparative solidity of the whole mass ; while the latter, in general, on the evidence of volcanic action, the crumpling and folding of the strata in mountain ranges, its general flexibility down to the most recent geological times, and the rate of increase of temperature in descending beneath the surface, contend for a crust of minimum thickness as alone compatible with these phenomena.

The question of underground temperature, which is a subject equally affecting the argument on both sides, had engaged the author's attention in connection with an inquiry respecting volcanic action, and he was induced to tabulate the results to see how far the usually received rates of increase were affected by various interfering causes—not that most of them had not received due attention, but it was a question whether sufficient allowance had been made for them.

Although Gensanne's first experiments were made in 1740, and others were subsequently made by Daubuisson, Saussure, and Cordier, in coal and other mines, it was not until the construction of deep artesian wells commenced in the second quarter of this century, and Walferdin introduced his overflow thermometer, and precautions were taken against pressure, that the more reliable observations were made and admirably discussed by Arago. The Coal Commission of 1866 collected a mass of important evidence bearing on the question, and in 1867 a Committee of the British Association was appointed to collect further information. Under the able superintendence of Prof. Everett, a series of valuable experiments with improved instruments has

been made, and full particulars published in the *Annual Reports* of 1868-83.

But notwithstanding the precautions taken, and the accuracy of the experiments, they present very wide differences in the thermometric gradient, ranging from under 30 to above 120 feet per degree F. Consequently different writers have adopted different mean values. On the Continent one of 30 m. per degree C. has been commonly adopted, while in this country some writers have taken a mean of 50 feet per degree, and others of 60 feet or more. The object which the author has in view is to see whether it is not possible to eliminate the more doubtful instances, and to bring the probable true normal gradient within narrower limits. In so doing he confines himself solely to the geological side of the inquiry.

In a general list, Table I., he gives all the recorded observations in the order of date. The list embraces observations at 530 stations in 248 localities. The most reliable of these he classifies under three heads in Tables II., III., and IV.

(1) Coal mines.
(2) Mines other than coal.
(3) Artesian wells and bore-holes.

To which tunnels are added in a supplement.

The author then proceeds to point out that the gradients given in many of the earlier observations were wrong in consequence of neglecting the height of the surface, and from the exact mean annual temperature of the locality not being known. They also differed amongst them elves from taking different surface temperatures, and starting from different datum levels. To these he endeavours to assign a uniform value.

The essential differences in the results in several tables depend, however, upon dissimilar geological conditions, which unequally affect the conductivity of the strata, and disturbing causes of different orders. In the mines the latter are :—

(1) The currents established by ventilation and convection.
(2) The circulation of underground waters.
(3) Chemical reactions.
(4) The working operations.

And in artesian wells—

(1) The pressure of the water on the thermometers.
(2) Convection currents in the column of water.

In the latter experiments pressure has been thoroughly guarded against, but against the subtle influence of the other causes, though long known, it is more difficult to guard.

Coal Mines.—The author then proceeds *seriatim* with each subject, commencing with coal-mines. In these he shows that ventilation and convection currents have rendered many of the results unreliable, as he shows to have been the case in the well-known instance of the Dukinfield coal pit. The circulation of air in coal pits varies from 5000 to 150,000 cubic feet per minute, and tables are given to show how this variously affects the temperature of the coal at different distances from the shaft, *though on the same leve'.* As a rule, the deeper the pit the more active is the ventilation, and therefore the more rapid the cooling of the underground strata. In some pits the indraughted air has been known to form ice, not only in the shaft, but icicles in the mine near the shaft.

The cooling effects of ventilation are shown to begin immediately that the faces of the rock and coal are exposed, and as the hotter (and deeper) the pit, and the more gassy the coal, the more active is the ventilation, so these surfaces rapidly undergo a cooling until an equilibrium is established between the normal underground temperature and the temperature of the air in the gallery. Judging by the effects of the diurnal variations on the surface of the ground, it is clear that an exposure of a few days must, when there is a difference of 10° to 12° or more between the air in the gallery and the normal temperature of the rock, tell on the exposed coal and rock to the depth of 3 to 4 feet —the usual depth of the holes in which the thermometers are placed. The designation of "fresh open faces" is no security, as that may mean a day or a week, or more. The author considers also that so far from the length and permanence of the experiment affording security, he is satisfied on the contrary that those experiments in which it is stated that the thermometer has been left in the rock for a period of a week, a month, or two years without any change of temperature, affords *prima facie* evidence of error, inasmuch as it shows that the rock has so far lost heat as to remain in a state of equilibrium with the air at the lower temperature in constant circulation.

Another cause of the loss of heat which requires some notice is the escape of the gas, which exists in the coal either in a highly compressed, or, as the author thinks more probable, in a liquid state. A strong blower of gas has been observed to render the coal sensibly cooler to the touch. In another case whereas the temperature of the coal at the depth of 1269 feet was 74° F., at the greater depth of 1588 feet in a hole with a blower of gas it was only 62°. One witness observed that "the coal gives out heat quicker than the rock." There is generally a difference of 2° or 3° between them.

On the other hand, the coal and rocks when crushed and in "creeps" acquire a higher temperature owing to the liberation of heat.

The effects of irregularities of the surface on the underground isotherms, although unimportant in many of our coal-fields, produce very decided results in the observations on the same level in the mines among the hills of South Wales. Sections are given to show how the temperature rises under hills and falls under valleys, showing that it is often essential to know not only the depth of the shaft but the depth beneath the surface at each station where the experiments are made.

The author therefore considers that to assign a value to an observation we should know (1) height of pit above sea-level ; (2) the exact mean annual temperature of the place ; (3) depth beneath the surface of each station ; (4) distance of the stations from the shaft ; (5) temperature and columns of air in circulation ; (6) length of exposure of face ; (7) whether or not the coal is gassy. The dip of the strata and the quantity of water are also to be noted.

Very few of the recorded observations come up to this standard, and the author has felt himself obliged to make a very restricted selection of cases on which to establish the probable thermometric gradient for the coal strata. Amongst the best observations are those made at Boldon, North Seaton, South Hetton, Rosebridge, Wakefield, Liége, and Mons. These give a mean gradient of 49½ feet for each degree F. The bore-holes at Blythswood, South Balgray, and Creuzot give a mean of 50·8 feet.

Mines other than Coal.—The causes affecting the thermal conditions of these mines are on the whole very different to those which obtain in coal mines. Ventilation affects both, but in very unequal degrees. In mineral mines it is much less active, and the cooling effects are proportionately less. On the other hand the loss of heat by the underground waters in mineral mines is very important. In some mines in Cornwall, the quantity of water pumped up does not exceed 5 gallons, while in others it amounts to 200 gallons per minute. The Dolcoath mine used to furnish half a million gallons of water in the twenty-four hours, while at the Huel Abraham mine it reached the large quantity of above 2,000,000 gallons daily. The rainfall in Cornwall is about 46 inches annually, and of this about 9 inches pass underground. In the Gwennap district, where 5500 acres were combined for drainage purposes, above 20,000,000 gallons have been discharged in the twenty-four hours from a depth of 1200 feet. This water issues at temperatures of from 60° to 68°, or more than 12° above the mean of the climate, showing how large must be the abstraction of heat from the rocks through which the waters percolate.

Hot springs are not uncommon in these mines. They are due to chemical decomposition, and to water rising in the lodes and fissures from greater depths. The decomposition which goes on in the lodes near the surface, and whereby the sulphides of iron and copper are reduced ultimately to the state of peroxides and carbonates of those metals, is a permanent cause of heat, especially apparent in the shallower mines. On the other hand, where the surface waters pass rapidly through the rocks, they lower the temperature and give too low readings.

While ventilation, therefore, reduces the rock temperature, the water which percolates through the rock, and more especially through the veins and cross-courses, sometimes raise, and at other times lower, the temperature of the underground springs. Mr. Were Fox, who for many years made observations on the underground temperature of the Cornish mines, gave the preference to the rocks ; while Mr. Henwood, an observer equally experienced and assiduous, considered that the underground springs gave surer results. Both were of course fully alive to all the precautions that in either case it was necessary to take to guard against these interferences.

Taking ten of the most reliable of Mr. Henwood's observations at depths of from 800 to 2000 feet, the mean gives a thermometric gradient of 42·4 feet per degree, but Mr. Henwood himself gives us the mean of 134 observations to the depth of

1200 feet, a gradient of 41·5 feet to the experiments in granite, and of 39 feet to those in slate.

Taking the experiments of Mr. Fox in eight mines, varying in depth from 1100 to 2100 feet, the mean of the experiments made in the rock gave a gradient of 43·6 feet per degree, or for the mean of the two observers we have a gradient of 43 feet per degree.

For the foreign mines, in the absence of fuller data, and especially failing in information of the depth of the station beneath the surface, which in the hilly district of Freiberg and Hungary introduces an element of great uncertainty, it is impossible to arrive at any safe conclusion.

Artesian Wells and Borings.—This class of observations presents results much more uniform, and whereas the mines observations were made, the one in crystalline, and the other in unaltered Palæozoic rocks, the wells are, with few exceptions, either in the softer and less coherent rocks of Cretaceous, Jurassic, and Triassic age, which are much more permeable, and, as a rule, much less disturbed.

The causes of interference are mainly reduced to pressure on the instruments and convection currents. The early experiments, where no precautions were taken against these, are, with few exceptions, unreliable, and must be rejected. The larger the bore-hole, the greater the risk of convection-currents, and Prof. Everett has shown that in many cases of deep and large artesian borings, the water which lodges in them is reduced to a nearly uniform temperature throughout the whole depth by the action of these currents. In the deep boring at Sperenberg, before the introduction of plugs to stop these currents, it was found that the temperature near the top of the bore was rendered 4°·5 F. too high, and at the bottom, at a depth of 3390 feet, 4°·6, if not 6°·7, too high by the currents.

Taking the bore-holes in which the water does not overflow, and where, owing to the precautions against these sources, such as those of Kentish Town, Richmond, Grenelle, Sperenberg, Pregny, and Ostend, we get a mean gradient of 51·9 feet per degree.

Overflowing artesian wells should, if we were sure of all the conditions, give the best and most certain results. Taking those where the volume of water is large, and the observations made by competent observers, as in the case of the wells of Grenelle, Tours, Rochefort, Mondorff, Minden, and others, we obtain a mean of 50·2 feet, or, taking the two sets of wells, of 51 feet per degree.

The author, however, points out a source of possible error in those wells, arising from a peculiarity of tubage which requires investigation, and owing to which he thinks the water may suffer a loss of heat in ascending to the surface.

With respect to the extra-European wells, more particulars are required. It may be observed, however, that the wells in the Sahara Desert, which were made by an experienced engineer accustomed to such observations, the mean of. eleven overflowing wells, at depths of from 200 to 400 feet, gave 36 feet per degree.

Tunnels.—For the Mont Cenis Tunnel, allowing for the convexity of the surface, Prof. Everett estimates the gradient at 79 feet, and for the St. Gothard, 82 feet per degree. But Dr. Stapff found in the granite at the north end of the tunnel a much greater heat and more rapid gradient, for which there seemed no obvious explanation. Though this axis of the Alps is of late Tertiary date, the author points out that it cannot be due to the protrusion of the granite, as the Swiss geologists have shown that the granite was in its present relative position and solidified before the elevation of this last main axis of the Alps, and he suggests that the higher temperature may be a residue of the heat caused by the intense lateral pressure and crushing of the rocks which accompanied that elevation, for in the crushing of a rigid material such as rock almost the entire mechanical work reappears as heat.

Conductivity of the Rocks. Effects of Saturation and Imbibition.—Some of the apparent discrepancies in the thermometric gradients are no doubt due to differences in the conductivity of the rocks. Applying the valuable determinations of Profs. Herschel and Lebour to the groups of strata characterising the several classes of observations, the following results are obtained :—

	Mean conductivity k		Mean resistance r
(1) Carboniferous strata	·00488	...	275
(2) Crystalline and schistose rocks ...	·00546	...	184
(3) Triassic and Cretaceous strata ...	·00235	...	465

From this it would appear that the conductivity of the rocks associated with the mineral mines is twice as great as that of the artesian wells class. But all the experiments, with the exception of three or four, were made with blocks of dried rocks, and those showed a very remarkable difference ; thus, for example, dry New Red Sandstone gave k0·00250, whereas when wet it was increased to k0·00600. The author remarks that as all rocks below the level of the sea and that of the river valleys are permanently saturated with water, dry rocks are the exception and wet rocks the rule in nature, consequently the inequalities of conductivity must tend to disappear. The power of conduction is also greater along the planes of cleavage or lamination than across them, and therefore the dip of the strata must also exercise some influence on the conductivity of different rocks and "massifs." With respect to the foliated and schistose rocks, M. Jannettaz has shown that the axes of the thermic curve along and across the planes of foliation and cleavage are in the following proportions :—

Gneiss of St. Gothard	...	...	...	1 :	1·50
Schists of Col Voza...	...	...	...	1 :	1·80
Cambrian slates, Belgium	...	...	1 :	1·98

This cause will locally affect the rock masses.

Conclusion.—The author deduces from the three classes of observations a general mean thermic gradient of 48 feet per degree F., but he considers this only an approximation to the true normal gradient, and that the readings of the coal-mines and artesian-well experiments are, owing to the causes he enumerates, still too high. He also discusses the question whether or not the gradient changes with the depth. His own reduction of the observations gave no result, but he points out that in all probability the circulation of water arising from the extreme tension of its vapour is stayed at a certain depth ; while it has been shown experimentally that the conductivity of iron diminishes rapidly as the temperature increases, and this may possibly in a different degree apply to rocks. If, therefore, there is any change, these indications would be in favour of a more rapid gradient.

Taking all these conditions into consideration, the author inquires whether a gradient of 45 feet per degree would not be nearer the true normal than even the one of 48 obtained by the observations.

Linnean Society, February 19.—Prof. P. Martin Duncan, F.R.S., Vice-President, in the chair.—The Rev. L. Martial Klein was elected a Fellow.—Mr. Thiselton Dyer exhibited and made remarks on specimens of the peculiar Chinese " square bamboo " (*Bambusa quadrangularis*, Fenzi), and of articles made from the so-called " hairy bamboo " (probably *Dendrocalamus latiflorus*, Munro), sent from Wenchow to the Kew Museum by Dr. Macgowan.—Mr. T. Christy afterwards drew attention to silk fibres received from Auckland, New Zealand.—An abstract of Part iii. of the Rev. A. Eaton's monograph on the Mayflies (Ephemeridæ) was read by the Secretary. In this, the fourth series of group 2 of the genera are dealt with. Among representatives of Section 9, *Cloën* is distinguished by absence of hind wings, *Callibætis* by costal projection and cross-veinlets of its broad obtuse hind wings, *Baetis* by small or absence of costal projection and deficiency of cross veinlets, and *Centroptilum* by extreme narrowness of hind wings and slenderness of costal projection. The distinctive characteristics of sections 10 and 11 of the genera are also taken into consideration, and full descriptions of many new species given.—Then followed notes on the European and North American mosses of the genus *Fissidens*, by Mr. W. Mitten. Referring to the more recent important contributions of Dr. Braithwaite's British Moss-Flora, and Messrs. Lesquereux and James's North American Mosses, and taking into account definitions of older writers, such as Dillenius, Hedwig, Swartz, and others, Mr. Mitten endeavours to arrange the entire group afresh, partly in a tabular form, and afterwards supplementing this by notes on the individual species.—A paper was read by Prof. P. M. Duncan on the anatomy of the Ambulacra of the recent Diadematidæ. The author described the arrangement of the compound plates of the genera of *Diadema*, *Echinothrix*, *Centrostephanus*, *Atropyga*, *Micropyga*, and *Aspidadiadema*. The first three genera have triplets, consisting of primaries, the adoral and aboral plates being low and broad, and the second, or central plate, being a large primary. Nea, the peristome there is deformity of this typical arrangement and in *Echinothrix* a demiplate may enter, but it is never the second plate. In *Astropyga* the triplets are arranged so that the

majority are on the *Diadema*-type, and the exceptions were recorded. The structure of the triplets of *Micropyga* is unique, and the arrangements, leaving out the position of the pores, is somewhat like that of *Cœlopleurus*. *Aspidodiadema*, as has been explained by A. Agassiz, is like *Cidaris* in its ambulacra.

Mathematical Society, February 12.—J. W. L. Glaisher, F.R.S., President, in the chair.—Miss Emily Perrin, Ladies College, Cheltenham, was elected a Member, and Mr. J. Griffiths was admitted into the Society.—Mr. Tucker read the following papers :—" Sur les Figures semblablement Variables," by Prof. J. Neuberg ; on the extension of Ivory's and Jacobi's distance-correspondences for quadric surfaces, by Prof. J. Larmor ; and some properties of a quadrilateral in a circle the rectangles under whose opposite sides are equal, by R. Tucker. Messrs. Jenkins and S. Roberts spoke on the subject of the first paper. A clear idea of Mr. Tucker's communication will be obtained by drawing a figure for the following particular case :—Take a quadrilateral, $A B C D$, in a circle, with its angles A, $B = 58°$, $112°$ respectively, and $A B$ (the unit of length) equal the side (in this case) of the inscribed square. Let $B C = \lambda$, $C D = \mu$, $D A = \nu$; then if two sets of lines drawn in the same *senses* with the respective sides from the two ends make with those sides (in the particular case) angles of $38°$, these lines will intersect in two sets of 4 lines in P, P' (analogous to the Brocard points of a triangle), and in four sets of 2 lines in F, G, H, K. The quantities λ, μ, ν, are so related that $\lambda \nu = \mu$, hence we see that all such quadrilaterals have the rectangles under their opposite sides equal. The six points lie on a circle which also passes through the circum-centre (O), point of intersection (E) of the diagonals $A C$, $B D$, and through the mid-points M, L of those diagonals. In fact, since $O E$ is a diameter of this new circle, the mid-points of any chord of the circum-circle which passes through E lies on the small circle. P, P' are the foci of an ellipse inscribed in $A B C D$. Further properties are $O P = O P'$, $A P . B P . C P . D P = A P' . B P' . C P' . D P'$, and many other metrical and angular relations belong to the above collection of points. If instead of $38°$ we take ϕ, then ϕ is found by the equation $\operatorname{cosec}^2 \phi = \operatorname{cosec}^2 A + \operatorname{cosec}^2 B$. The side $A'B$ subtends at an opposite vertex an $\angle \theta_1$, such that $\cot \theta_1 = \cot \phi - \cot A - \cot B$, with similar values for the other angles. The circum-radius (R) is found by—

$$2 R^2 = (\cot \phi - \cot A)(\cot \phi - \cot B),$$

and that of the small circle (ρ) by

$$2 \rho = R \sec \phi \sqrt{\cos 2\phi}.$$

Relations connecting the θ set and ϕ with the Brocard angles of the 4 constituent-triangles are easily obtained in a neat form. If through E lines are drawn parallel to the sides cutting them in eight points, these points lie on a circumference which has many properties analogous to those of the " *T.R.* " circle of a triangle. If ρ^1 is its radius, then $\rho^2 + \rho'^2 = R^2/_2$: the eight points from two equal inscribed quadilaterals similar to the given figure, and whose sides make the same angle ϕ with the given sides.

Geological Society, January 28.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Frederick John Cullis, Henry Dewes, Henry Hutchings French, Jacob Hort Player, and the Hon. Donald A. Smith, were elected Fellows, and Prof. F. Fouqué, of Paris, and Dr. Gustav Lindström, of Stockholm, Foreign Correspondents of the Society.—The President called attention to the great loss the Society had sustained in the sudden and unexpected death of Dr. J. Gwyn Jeffreys, F.R.S., &c., who had been for twenty-one years continuously a Member of the Council, and for fourteen years of that time had performed most valuable services to the Society as Treasurer.—The following communications were read :—The Boulder Clays of Lincolnshire : their geographical range and relative age, by A. J. Jukes-Browne, F.G.S. The author commenced by referring to the late Mr. Searles V. Wood's papers on the glacial beds of Yorkshire and Lincolnshire, and stated, as the result of his own investigations, that two distinct types of boulder clay occur in Lincolnshire : (1) the gray or blue clay ; (2) the red and brown clays, the former undoubtedly an extension of the upper or chalky boulder clay of Rutland and East Anglia, while the second includes the purple and Hessle clays of Mr. S. V. Wood. These two types of boulder clay are very rarely in contact with each other. The brown boulder clays of East Lincolnshire rest upon a broad plain of chalk, which appears to terminate westward in a concealed line of cliff, this cliff-line coinciding with the strike of the slope which descends from the

chalk wolds to the boulder clay plateau by which they are bordered. The present boundary line of the boulder clay runs along this slope for long distances, though in many places the clay has surmounted the slope and caps the hills to the west of it. From Louth the main mass of the " brown clay " is bounded by a line drawn through Wyham, Hawerby, Laceby, and Brocklesby to Barrow and Barton on Humber, sweeping around the north end of the Lincolnshire wolds and occurring on both sides of the Humber. Previously to the author's inspection of this district no purple or Hessle clay had been discovered west of South Ferriby, and these clays were supposed to be entirely absent on the western side of the wolds. The officers of the Survey have, however, mapped several tracts of such clay in the valley of Ancholme. It occupies the surface at Horkstow, Winterton Holme, Winterton, and Winteringham. It probably underlies the alluvium of the Ancholme near and south of these places, and occurs again at higher levels in the neighbourhood of Brigg. South of Brigg it has been seen at low levels on either side of the valley of the Ancholme, as far as Bishop's Bridge near Glentham. Beyond this point it was not traceable in the Ancholme valley, but south of Market Rasen patches of reddish-brown clay, mottled with gray, and containing small flints and pebbles of chalk, occur, and cap the low ridges separating the valleys of the brooks. Another tract of boulder clay, which the author considers to belong to the same series, occupies the western border of the fenland south-east of Lincoln, what is left of it forming a ridge which runs southward for many miles. It passes eastward beneath the fen deposits ; and similar mottled clay was seen in the excavations for the Boston Docks beneath about twenty feet of fen clays, &c., and resting upon blue boulder clay of the " chalky " type. Besides this section at Boston, there are very few places where the two types of clay are in contact, or so near as to afford any evidence as to their relative age. Near East and West Real, and again near Louth, the " brown clays " are banked against the slopes of hills which are capped with the " chalky clay." The same is the case also near Brigg, where the country seems to have been originally covered by a sheet of the chalky clay, through which valleys were eroded into the Jurassic clays, and the brown (Hessle) clay is found only in these valleys. The author concludes, therefore, that the " Brown-clay series " is of much newer date than the " Blue and Grey series." In conclusion the author summed up the inferences drawn in the paper, correlated the Basement clay of Holderness with the Chalky clay of Lincolnshire, and suggested that the Purple clay may be confined to the east side of the wolds. The classification he would propose is therefore as follows :—

	Lincolnshire.	Yorkshire.
Newer Glacial.	Hessle clay.	Hessle and upper red clay of coast.
	Purple clay.	Purple clay.
Older Glacial =	Chalky clay.	Basement clay.

—On the geology of the Rio Tinto Mines, with some general remarks on the pyritic region of the Sierra Morena, by J. H. Collins, F.G.S. After briefly describing the geographical position of the Rio Tinto mines and the occurrence at the same of pyritous ores amongst slates and schists which abut against gneissose rocks to the north, and pass under Tertiary beds to the southward, the author proceeded to consider the general characters and associations of the pyrites-deposits, and then gave a general account of the Rio Tinto district. The slates were described, and the fossil evidence recapitulated upon which an Upper Devonian age had been assigned to them. Analyses were furnished to show the changes due to weathering and to infiltration. The various intrusive rocks (syenite, diabase, and porphyries) occurring in the schists were described, and analyses of them given. The sedimentary iron ores and their composition were next noticed, and the author ascribed their formation to deposition in lakes. The masses of pyrites which furnish the principal ores of Rio Tinto were then described, their mode of occurrence in fissures between dissimilar rocks explained, and their formation discussed. The different kinds of ore obtained from the mines were noticed in detail, and several analyses added, giving samples both of the mixed ores and of the pure minerals. The manganese lodes were next described, and shown to be parallel to the pyrites fissures, and frequently to be only branches of the latter. A summary of the author's conclusions as to the stratigraphy of the district, the ore deposits, and the surface-geology was appended.—On some new or imperfectly known Madreporia from the Great Oolite of the counties of Oxford, Gloucester, and Somerset, by R. F. Tomes, F.G.S.

Physical Society, February 14.—Annual General Meeting. —Prof. Guthrie, President, in the chair.—Prof. G. Fuller was elected a Member of the Society.—The President then read the Report of the Council, in which the Society was congratulated upon the number of original communications read—forty-three during the past year. Among the works undertaken by the Society may be mentioned the publication of the first volume of "Joule's Scientific Works"; a second volume, containing accounts of researches conducted by Mr. Joule in conjunction with other scientific men, would be published shortly.—The Treasurer presented a highly satisfactory report.—The Council for the ensuing year was then elected, the result of the election being as follows:—President: Prof. F. Guthrie, Ph.D., F.R.S.; Vice-Presidents (who have filled the office of President): Dr. J. H. Gladstone, Prof. G. C. Foster, Prof. W. G. Adams, Sir W. Thomson, Prof. R. B. Clifton; Vice-Presidents: Prof. W. E. Ayrton, Shelford Bidwell, Lord Rayleigh, Prof. W. C. Roberts; Secretaries: Prof. A. W. Reinold and Walter Baily; Treasurer: Dr. E. Atkinson; Demonstrator: Prof. F. Guthrie; other Members of Council: C. Vernon Boys, C. W. Cooke, Prof. G. Forbes, Prof. F. Fuller, R. T. Glazebrook, Dr. J. Hopkinson, Prof. H. McCleod, Prof. J. Perry, Prof. J. H Poynting, Prof. S. P. Thompson; Honorary Member: Prof. M. E. Mascart.— The customary votes of thanks to the Committee of the Council of Education and to the President, Secretaries, and other officers having been passed, the meeting resolved itself into an ordinary meeting of the Society.—Miss Marks described a new line and area divider. This instrument consists of a hinged rule with a firm joint. The inside edge of each limb is bevelled, and presents a straight edge. One limb is divided on both edges into a number of equal parts, and is fitted by a groove on its outer edge to a plain rule, along which it can slide. To divide a line into a given number of equal parts, the hinged rule is slid along the plain rule till the nth division from the joint is opposite a fixed mark on the plain rule; it is then placed on the paper so that the nth division on the graduated straight edge coincides with one end of the given line, and then opened till the straight edge on the inner edge of the other limb passes through the other extremity. The plain rule is then pressed firmly down and the hinged rule slid along it. As each division of the graduated edge passes the fixed mark, the intersection of the moving edge with the given line is marked, and thus the line is divided into n equal parts. The instrument may be used in this way to draw any given number of equidistant parallel lines between two given points. It may be conveniently used in working out indicator diagrams and measuring areas.—Mr. Walter Baily described certain improvements made in his integrating anemometer, which has been previously described. The improvements consist in the substitution of mechanical counters for electrical ones, as it was found, in the recent observations with the instrument at Kew, that the extra friction of the "contact" was sometimes sufficient to stop the motion. The mechanical counters were found to work satisfactorily in every respect.—Prof. Guthrie showed some specimens exhibiting the similarity of fracture of Canada balsam and glass. The glass had been cracked by heating a metal ring to which it was attached; the Canada balsam had been overheated in a small dish and allowed to cool.

Zoological Society, February 17.—Osbert Salvin, F.R.S., Vice-President, in the chair.—Mr. F. E. Beddard, F.Z.S., read a paper upon the structure of the Cuckoos (Cuculidæ), and pointed out the differences in the pterylosis and the structure of the syrinx in the various forms which he had examined. It was proposed to divide the family into three sub-families: Cuculinæ, Phœnicophainæ, and Centropodinæ.—Mr. F. E. Beddard read a paper upon the heart of *Apteryx*, and called attention to the variations in the condition of the right auriculo-ventricular valve observed in different individuals of this bird.—A communication was read from Mr. M. Jacoby, containing the first part of an account of the Phytophagous Coleoptera obtained by Mr. George Lewis during his second journey in Japan, from February, 1880, to September, 1881.

Geologists' Association, February 6.—W. H. Hudleston, F.R.S., in the chair.—The annual meeting was held at University College.—The following Officers were elected for the ensuing year:—President: W. Topley, F.G.S., Assoc.Inst.C.E.; Vice-Presidents: Prof. J. F. Blake, M.A., F.G.S., T. V. Holmes, F.G.S., W. H. Hudleston, F.R.S., F.G.S., F.C.S., Henry Hicks, M.D., M.R.C.S., F.G.S.; Treasurer: J. Hopkinson, F.G.S., F.L.S.; Secretary: John Foulerton, M.D., F.G.S.;

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EDINBURGH

Royal Society, February 2.—Mr. Thomas Stevenson, President, in the chair.—The President delivered an address, in which he discussed the erection of training-walls at the mouth of the Mersey. He would strongly condemn such a procedure, asserting that the inevitable result would be the silting up of the approaches to Liverpool.—Prof. Tait submitted a paper on condensation and evaporation. He pointed out that the present mode of treating the conditions of a liquid in presence of its vapour were not rigorous, inasmuch as the pressure is undoubtedly different in the two parts, while in the surface-layer between them there is a complex form of stress. If attention be confined to the isothermals of the interior parts of a liquid, or of its vapour, the present method will apply rigorously. With this proviso the isothermals under the critical point consist of two parts separated by an asymptote—one belonging to the liquid, the other to the vapour. This accords with the fact that liquids can be subjected to hydrostatic tension, and that Aitken has shown that true vapour cannot be condensed without a nucleus. —Mr. John Rattray, of the Granton Marine Station, communicated a note on Ectocarpus.—The Rev. J. M. Macdonald exhibited some specimens from Philadelphia which had the appearance of large vegetable fossils. Mr. John Murray and Prof. Duns pronounced them to be merely inorganic accretions around reeds.

Mathematical Society, February 13.—Mr. A. J. G. Barclay, President, in the chair.—Prof. Tait communicated a note on a plane strain, which was read by Mr. W. Peddie; Dr. Muir gave an account of a paper by Mr. P. Alexander on Boole's proof of Fourier's double integral theorem, and afterwards enunciated several theorems of his own on the arbelos; Mr. Peddie discussed reflected rainbows; Mr. Allardice gave a note on spherical geometry: and Mr. A. Y. Fraser made some remarks on a problem in plane geometry.

CAMBRIDGE

Philosophical Society, February 2.—Prof. Foster, President, in the chair.—Prof. C. S. Roy, M.A., was elected a Fellow.—The following communications were made:—On the Zeta-function in elliptic functions, by Mr. J. W. L. Glaisher.— On a certain atomic hypothesis, by Prof. K. Pearson. Communicated by Mr. H. T. Stearn.—On a Young's eriometer, by Mr. R. T. Glazebrook.

PARIS

Academy of Sciences, February 16.—M. Bouley, President, in the chair.—On the inaccuracies committed in the employment of the usual formulas in the reduction of the polar stars and in determining the astronomic collimation. The correct terms required to remove these errors. Method of observing the polar stars at any meridian distance, by M. Lœwy.—Description of the nervous system of *Ancylus fluviatilis*, by M. H. de Lacaze-Duthiers.—On the order of appearance of the first vessels in the leaves of the cruciferæ; third part, *Crambe maritima, juncea,* and *cordifolia,* by M. A. Trécul.—Experiments on some phenomena of the movement of water in an apparatus employed to raise the liquid by means of a mechanical fall without piston or lifting valve, by M. A. de Caligny.—On the resistance of keels in connection with the velocities of 20 and 21 knots an hour recently obtained without special extra motor power, by M. A. Ledieu.—On the oïdium, *Phoma vitis,* mildew (*Peronospora viticola*), and some other cryptogamic diseases prevalent for some years past in the European vineyards, by M. H. Marès.— On the density and figure of the earth, by Gen. L. F. Menabrea. The author's researches tend to confirm the anticipations of Newton that the mean density of the earth would be found to lie between five and six times that of water.—On the development of the vascular apparatus, and of the reproductive organs

in the comatulæ, by M. Edm. Perrier.—Extraction of the green colouring matter of leaves; definite combinations formed by chlorophyll, by M. Er. Guignet. — On some theorems in algebra, by M. Stieltjes.—On the heating power of coal-gas in various states of dilution, by M. A. Witz. From his experiments the author infers that the complete combustion of gas requires a dilution of over six volumes of air, the effect of the dilution thus being the reverse of what might be supposed *a priori.*—On the laws of solution, by M. H. Le Chatelier. From his researches the author concludes that solubility increases with the temperature for bodies whose solution absorbs heat, decreases for those that liberate heat, and remains unchanged when the heat of solution is null.—On the solution of the carbonate of magnesia by carbonic acid, second note, by M. R. Engel.—On a crystallised hydrate of phosphoric acid, by M. A. Joly.—Note on the cellular structure of cast steel, by MM. Osmond and Werth.—On glycol, its preparation and solidification, by M. G. Bouchardet. A very pure preparation of glycol, obtained by a solution of carbonate of potassa acting on the bromide of ethylene, was found to boil at 198° C., and to solidify at temperatures varying from – 11°·5 to – 25°.—Note on monochlorhydric glycol, by M. G. Bouchardat.—Action of the diastase of malt on natural starch, by M. L. Brasse.—On the rotatory power of the solutions of cellulose in Schweizer's liquid, by M. Alb. Levallois.—Observations regarding the organisms to which fermentation is due; claim of priority of discovery in connection with some remarks of M. Pasteur on a recent note of M. Duclaux, by M. A. Béchamp.—Note on the anatomical structure and classification of *Halia priamus* (Risso), by M. J. Poirier.—On the anatomy of the brachiopods of the genus Crania, by M. Joubin.—On the nervous system of a Fissurella (*F. alternata*), by M. L. Boutan.—On the origin of the metalliferous ores existing on the periphery of the central plateau of France, and especially in the Cevenne highlands, by M. Dieulafait.—On the results of M. Sokoloff's studies on the formation of sandy dunes in Central Asia, by M. Venukoff.

BERLIN

Physiological Society, January 21.—Dr. von Monakow, referring to his anatomical investigations of the brain, communicated an account of those relating to the central origin of the optic nerve. He had enucleated on one or both sides the bulbus in young rabbits and cats, and, after an interval of some months, examined the changes which had set in as a result of that violence done to the brain. In each case he found regular ascending atrophy capable of being traced up to the origin of the nerves. By this means he had been able to recognise as central original spots of the nervi optici the corpus geniculatum externum, the pulvinar and the anterior corpora quadrigemina. The corpus geniculatum and the pulvinar consisted of large multipolar cells, between which lay a gray medullary substance, which, on being coloured with carmine, showed a particularly strong tinge. After the enucleation, atrophy of the gray medullary substance was observed in both, while the cells remained altogether intact. On colouring with carmine, the somewhat shrunken organs appeared much paler than in the normal state. In the corpora quadrigemina five different layers of small and large cells and fibrous bands were distinguished. Of these the three innermost layers lying towards the ventricle remained intact, while the two exterior cellular layers were atrophied or were altogether wanting The degeneration and disturbance of growth after the enucleation of the bulbus had not, however, extended beyond these primary centres of the optic nerve. Dr. von Monakow had, furthermore, removed particular parts of the cerebral cortex lying within Munk's sphere of vision, and the degeneration and atrophy which succeeded this injury, and, extended peripherically, could be followed through Gratiolet's fibres on to the three centres of optic nerves above mentioned, the corpus geniculatum externum, the pulvinar and the anterior corpora quadrigemina (*Vierhügeln*), and beyond these centres as far as the tractus opticus and the optic nerves. It was an interesting fact that after the injury of the cerebral cortex the degeneration of the three centres of optic nerves was of a different character from that which set in after the peripherical enucleation. The corpus geniculatum and the pulvinar were now altered in such a manner that it was mainly the cells which either showed degeneration or were entirely wanting. In the anterior corpora quadrigemina, likewise, it was other layers—namely, the third medullary layer and the larger cells—which were overtaken by degeneration. The speaker had had the opportunity, in making a dissection, of substantiating on a man

who had long been suffering from diseased retina, that the degeneration in the case of man propagated itself centrally—towards the three centres before-mentioned—just as much as in the case of the rabbits operated on.—Dr. Weyl spoke on casein, which took quite an exceptional place among albuminous bodies. According to the most recent researches albuminous bodies contained only O, H, N, C, and S, but no phosphorus, and might be divided into (1) albumins or albuminous bodies soluble in water; (2) globulins, insoluble in water, but soluble in solution of common salt; (3) proteins, soluble neither in water nor solution of common salt, but in diluted alkalis. Finally, a fourth group of albuminous bodies was formed by such as were soluble in none of those reagents, but, except in this one characteristic, had no affinity to each other, such as fibrin, amyloid, casein, &c. Casein had hitherto been identified only in milk. It was an albuminous body, because under the agency of diluted muriatic acid and pepsin it yielded a pepton, and, besides, precipitated an insoluble substance, which must be classed among the nucleins. Casein contained phosphorus, and so was distinguished from all other albuminous bodies. In order to the demonstration of casein and its quantitative determination in milk, Dr. Weyl had, in conjunction with Dr. Frentzel, adopted a new and less detailed process than that of Prof. Hoppe-Seyler so universally introduced into practice. This new process consisted in diluting the milk threefold and reducing it with highly diluted sulphuric acid (1 : 1000). Thereupon a flaky precipitate at once segregated itself, which could be filtered off and weighed. The precision of this method was equal to that of Hoppe-Seyler's, and by means of it Dr. Weyl and Dr. Frentzel had begun to study quantitatively the transformation of casein into pepton and nuclein. The speaker hoped to be able soon to make communications regarding the result of this investigation.—Dr. Rossel had examined the nuclein of the yolk, in order to test the assertion of Mr. Michat that it resembled the nuclein of cellnuclei, an assertion which lent a chemical support to the view of Prof. His that the granules of the yolk entered as organic elements towards the upbuilding of the embryo, and formed the cell-nuclei. Dr. Rossel had isolated the nuclein of the yolk of hen-eggs, and, on examining it, had found it essentially different from the nuclein of cell-nuclei. While this latter contained the highly nitrogenous organic bases guanin and hypoxanthin, none of these bases were found in the nuclein of the yolk. The nuclein of the yolk was, therefore, essentially different from that of the cell-nuclei, and under the demonstration of this difference the support which, from the chemical side, had been afforded to the view of the transference of granular formations of the yolk into cell-nuclei, fell away.

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